PLUG POWER FUEL CELL DEMONSTRATION PROJECT
SARATOGA SPRINGS NAVAL SUPPORT UNIT
QUIET HARBOR COMPLEX

Mid-Point Project Description Report

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Prepared for

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CHINA LAKE, CALIFORNIA

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In accordance with Contract Number:
DACA42-02-C-0025

Overview

This report shall serve as the midpoint project status update for the U.S. Naval Air Weapons Station fuel cell demonstration program pursuant to DACA42-02-C-0025 at the Saratoga Springs - Naval Support Unit. Topics covered will include documentation of the installation process including completed site photos and performance data through October 2003.

Objectives

The installation and operation of PEM fuel cells at the Saratoga Springs Naval Support Unit (NSU) – Quiet Harbor Complex has objectives that further the missions of both the U.S. Naval Air Weapons Station and Plug Power. The following points summarize the common high-level objectives for this program:

- Allow assessment of fuel cells in supporting sustainable military installations;
- Increase the Navy's ability to more efficiently construct, operate and maintain its installations;
- Assess the role of PEM fuel cells in supporting the Navy's training, readiness, mobilization, and sustainability missions;
- Provide a technology demonstration site for military base market;
- Provide operational testing & validation of product to assess installation, grid interconnection, operation of systems in all seasonal conditions, and integration of units into an existing military base environment.
- Provide an understanding of military requirements in applications utilizing CHP and standby capabilities.

Plug Power, a New York State designer and manufacturer of Proton Exchange Membrane (PEM) fuel cells has extensive experience in the design and operation of PEM fuel cell systems since its inception in 1997. Plug's focus on natural gas powered fuel cell systems has resulted in the successful demonstration of systems with increasing reliability, reduced cost, and increasing functionality. Plug Power fuel cells have been sold to, and operated for New York State Energy Research and Development Authority, General Electric, DTE Energy Technologies, and the Long Island Power Authority. In addition, Plug Power has operating experience of integrated fuel cell systems of over 250,000 hours in laboratory, field demonstration, and prototypical environmental applications. Plug Power's initial approach to the marketplace is targeting electric and gas utility customers as well as government customers. This program supports Plug Power's recognition of the Department of Defense as a potentially significant customer for fuel cells in the future, and provides the opportunity for an initial assessment of the use of PEM fuel cells supporting military base infrastructure.

Equipment

Plug Power installed and commissioned eight natural gas fuel cell power systems at four separate sites within the NSU complex. Product specifications for the fuel cells installed are shown in Table 1. The natural gas powered fuel cell systems provide electricity to the facility and incorporate combined heat and power (CHP) capability. This capability allows waste heat to be recovered from the fuel cell and used to supplement the existing domestic hot water system at each site. Additionally, the fuel cell systems include a standby feature that allows the units to operate during periods of electric utility grid (Grid) outage as experienced in August 2003.

Table 1: Product Specifications

Comment	Specification
Unit Size	Base Unit with integral skid: 74"L x 32"W x 68"H (excludes 22" exhaust stack)
Installation Location	Outdoor
Grid Parallel	Yes (w/ standby capability)
Power Output/Set points	2.5kW, 4 kW, 5 kW
Remote monitoring capability	Via phone line
Output Voltage	120 VAC @ 60 Hz
Certification	Integrated System CSA International Listed; Inverter UL Listed
Power Quality	IEEE 519 or better
Emissions (steady-state)	NOx < 5 ppm Sox < 1 ppm CO < 50 ppm
Standard operating conditions	Temperature: O °F to 104 °F Elevation: up to 6,000 ft Noise: < 65 dBa @ 1 meter

Installation

The Quiet Harbor community includes twenty-five (25) four (4) unit townhouse style buildings containing a total of one hundred (100) units. Each group of four units has a common mechanical room and is served by forced hot air heat and an eighty- (80) gallon natural gas fired hot water heater.

Plug Power and NSU personnel identified four (4) townhouse buildings within the complex for the fuel cell installation – buildings 16, 17, 20 and 21.

Each site contains two (2) fuel cell systems:

- The upstairs apartments (C & D) at each site will be electrically fed by one fuel cell system.
- Thermally, the fuel cells will join together and supplement the common hot water system in the mechanical room.
- In standby mode, the fuel cells will continue to power the entire main apartment panels with the exception of the 240 VAC electric clothes dryer.

An extensive data monitoring and LAN setup was installed to maximize the data recovered during the demonstration. A high-speed internet connection transmits detailed system data with a resolution equivalent to that in the Plug Power laboratory.

Plug Power retained Industrial Process Design, Inc. (IPDI) for their engineering and general contracting services during the installation phase of this project. The scope of work included development of an engineering package containing all details of site construction, foundation preparation, installation of the natural gas, water and CHP systems, electrical interconnection and all miscellaneous piping, conduit, wiring and construction coordination activities. All work was performed under a lump-sum contract for a total of $67,950 or approximately $8,500 per system. IPDI held two sub-contracts for completion of the electrical and mechanical work. An installation timeline showing major milestones can be found in Table 2.

Table 2: Installation Timeline

Completion date	Task
November 27, 2002	**Contract signed by all parties**
November 28, 2002	Start site engineering
December 4, 2002	Foundation preparation for fuel cell placement
December 5, 2002	**System delivery and rigging**
December 24, 2002	Engineering package completed and approved by Plug Power
January 9, 2003	Start electrical construction
January 9, 2003	Start mechanical construction
February 27, 2003	Final electrical connections by Plug Power
February 27, 2003	Finish electrical construction
February 27, 2003	Finish mechanical construction
February 27, 2003	Initial system start-ups
February 27, 2003	**Town hall meeting and site walk-through**
March 13, 2003	Building inspection
March 13, 2003	Niagara Mohawk interconnection verification test
April 28, 2003	Installation of protective, wooden pipe covers
April 28, 2003	System repairs to address freeze damage from extended cold weather storage
April 29, 2003	**Commissioning of fuel cell systems**

Site Photographs

Bldg. 16 (Systems B175 & B176)

Bldg. 17 (Systems B173 & B174)

Bldg. 20 (Systems B170 & B171)

Bldg. 21 (Systems B168 & B169)

Typical Mechanical Rm. (showing data logging server)

Performance Data

Table 3 shows the fleet performance data for the first 6-months of unit operation (through October 31, 2003). For individual system performance data, refer to the attached spreadsheet NSU Mid point operational data.xls. Total harmonic voltage distortion (THD) measurements were taken in July 2003 as required by the contract. Results of the THD test can be found in Table 4.

Table 3: Fleet Data

Run Time (Hours)	34150.6
Time in Period (Hours)	35328
Availability (%)	96.67%
Energy Produced (kWe-hrs AC)	85626
Output Setting (kW)	2.50
Average Output (kW)	2.51
Capacity Factor (%)	48.48%
Fuel Usage, LHV (BTUs)	1.13E+09
Fuel Usage (SCF)	1117027
Electrical Efficiency (%)	25.87%
Thermal Heat Recovery (BTUs)	15592000
Heat Recovery Rate (BTUs/hour)	456.57
Thermal Efficiency (%)	1.38%
Overall Efficiency (%)	27.25%
Number of Scheduled Outages	22
Scheduled Outage Hours	152.4
Number of Unscheduled Outages	34
Unscheduled Outage Hours	1025

Table 4: Total Harmonic Distortion Measurements

Location	Unit	THD (Voltage)	Date	Technician
Apartment 16C	175	1.7%	7/1/2003	J. Morawski
Apartment 16D	176	1.9%	7/1/2003	J. Morawski
Apartment 17C	174	2.2%	7/1/2003	J. Morawski
Apartment 17D	173	1.7%	7/1/2003	J. Morawski
Apartment 20C	171	1.9%	7/1/2003	J. Morawski
Apartment 20D	170	2.7%	7/1/2003	J. Morawski
Apartment 21C	168	1.8%	7/1/2003	J. Morawski
Apartment 21D	169	2.8%	7/1/2003	J. Morawski

Points of Contact

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